MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2019/2020

EEE 7296 – ENERGY MONITORING AND AUDITING

14 OCTOBER 2019

2:30 PM – 5:30 PM (3 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 5 pages including cover page with 4 Questions only.
2. Answer ALL questions. All questions carry equal marks and the distributions of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.

Question 1

a) Define the following terms;
   i) Energy Audit [6 marks]
   ii) Energy Use Intensity [4 marks]

b) An office building in Malaysia is using the energy data given below. Assume 75% of the floor area are occupied and the operating time for the office is 8 hours daily, and the office is open for 5 days in a week. Calculate the Building Efficiency Index BEI ($kWh/m^2/year$). [15 marks]

Building data:

GFA = 35 m x 25 m

Common and Service Areas

1. Réception Lobby (8 m x 10 m)
2. Lift Lobby (6 m x 9 m)
3. Waiting Areas (5 m x 6 m)
4. Registration (6 m x 8 m)

Energy Data

I. Air conditioning usage in kWh
   For the first quarter of the year = 38,000
   For the second quarter of the year = 40,000
   For the third quarter of the year = 40,000
   For the fourth quarter of the year = 39,000

II. Lighting
   For the first quarter of the year = 15,000
   For the second quarter of the year = 20,000
   For the third quarter of the year = 21,000
   For the fourth quarter of the year = 17,000

Question 2

a) An industry is planning to replace its equipment after 7 years use of current equipment. An amount of RM 6,500 deposit is made today and a RM 8,500 deposit is made at the end of year two in its bank account that earns 4.5% per year. Determine for the future worth (accumulated total) at the end of seven years. [10 marks]

b) It is required to illuminate a workshop for 12 hours a day with a total of 18,000 lm. Refer to Table Q2ba, two kinds of lamps are considered in the design using a period of two years. Calculate and then compare the initial costs and running costs of the two systems over 2 years. [15 marks]

Continued...

Table Q2b

	Lamp A: Tungsten filament	Lamp B:Tubular fluorescent
Lamp wattage	100 W	60 W
Lamp efficacy	12 lm/W	60 lm/W
Lamp life	1000 hours	5000 hours
Installation costs	RM 15 each lamp	RM 30 each lamp
Lamp costs	RM 1.20 each	RM 4.50 each
Electricity costs	RM 0.26 per kWh	

Question 3

a) A factory is operating 24 hours daily, and consumes 650 MWh (650,000 kWh) of electrical energy during a 31-day billing period. During this period of time, its peak demand reaches to 1,900 kW. Calculate the factory load factor. Comment on lower and higher load factor in industry based on energy auditing and monitoring. What will be the highest value of load factor? [8 marks]

b) Briefly explain the working of the following;
   i) Light meter [5 marks]
   ii) What are the TWO types of light meters? Explain briefly each of them [8 marks]
   iii) wet-bulb temperature [4 marks]

Question 4

a) The hourly and half hourly energy data of an electrical motor manufacturing company is depicted in Table Q4a. The data is collected for two days, Monday and Thursday. The production rate for both the days is the same.
   i) Calculate the average load kWh/working hour, on Monday and Thursday [6 marks]
   ii) Analyze the data and point out if the company's production line is running efficiently. [2 marks]
   iii) Plot the energy value in kWhr versus time in a graph sheet. Coment on losses (if any) during the operation for each day. [4 marks]

Table Q4a

Duration/Time	8	9	10	11	12	13	14	15	15.30	16	16.30	17	17.30
Mon	2900	2900	3900	6100	6900	6800	5200	5100	4700	4500	3500	3400	3000
Thur	2850	2950	3850	5950	6800	6750	5300	5100	4800	4550	3450	3400	3000

Continued...

b) Administration block of Multi Media University (MMU), operating from 8.00 AM to 5.30 PM (Monday to Friday only) during a year, with daily visit of the guests/ students, has energy data and the number of visitors for three years which are given in Tables Q4-b1 and Q4-b2.

i) Calculate the total electricity energy consumed for each year

ii) Calcualte the average of the electricity energy used per visitor per year

iii) Analyze the energy data and explain if the building operates efficiently. Check both Data given in Table Q4-b1 and Q4-b2. [13 marks]

Table Q2-b1: Administrative block Electrical consumption (in kWh)

Month	**2016**	**2017**	**2018**
Jan	2400	2450	2500
Feb	2380	2430	2480
March	2480	2530	2580
April	2550	2580	2630
May	2600	2650	2700
June	2900	2950	3000
July	2500	2550	2600
Aug	2650	2700	2750
Sept	2450	2500	2550
Oct	2500	2550	2600
Nov	2350	2400	2450
Dec	2380	2430	2480

Table Q2-b2 : Number of visitors

	2016	**2017**	**2018**
Jan	1800	1790	1820
Feb	2000	2100	2200
March	2200	2300	2400
April	2250	2350	2400
May	2150	2200	2100
June	2230	2350	2450
July	2200	2000	2100
Aug	2100	2110	2200
Sept	2010	2015	2200
Oct	2150	2100	2350
Nov	2780	2500	2300
Dec	2000	2100	2230

Continued...

Equations used

$$BEI = \frac{(TBEC - CPEC - DCEC)}{(GFA - DCA - (GLA \times FVR))} \times \frac{52}{WOH}$$

TBEC – Total Building Energy Consumption (kWh/year)
CPEC – Carpark Energy Consumption (kWh/year)
DCEC – Data Centre Energy Consumption (kWh/year)
GFA – Gross Floor Area exclusive of car park (m^2)
DCA – Data Centre Area (m^2)
GLA – Gross Lettable Area (m^2)
FVR – Weighted floor vacancy rate of GLA (%)
52 – Typical weekly hours of office buildings in KL/Malaysia (hrs/week)
W O H – Weighted weekly operating hours of GLA exclusive of DCA (hrs/week)

$F_n = P\,(1+n*i)$
$F_n = P\,(1+i)^n$

$$\text{Load Factor} = \frac{\text{kWh in time period}}{\text{Peak kW} \times \text{\# hours in time period}}$$

$$\text{Monthly Load Factor} = \frac{\text{kWh in month}}{\text{Peak kW} \times \text{\# hours in the month}}$$

End of Paper